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ABSTRACT

The University of Wageningen takes care of only one faculty with 80 departments and about 4000 students. The university has been growing rapidly in recent years with an increase of 25 percent in first year students each year. Because of this growth and because of various social developments, the University Board recognizes the need for a good data system to support and to take part in the process of management; this means the system has to correspond with the intrinsic characteristics of the management system. The article describes briefly the process of management. The various aspects of the process, e.g., teaching and research task, personnel, etc. are strongly related; a qualitative description of some of these relationships is provided. The data system is derived from the properties of the management process and is designed on behalf of operational management with some thought given to strategic managment. (JMF)

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DESIGN AND IMPLEMENTATION OF A TASK/RESOURCE INFORMATION SYSTEM

Reported by the Planning Department of the

AGRICULTURAL UNIVERSITY OF WAGENINGEN

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CONTENTS

page

Introduction/Summary 1

Chapter I. Some remarks about the Process of Management 2
§ 1. Aspects and phases of the Process of Management 2
§ 2. The data system: a support to the Process of Management 3
§ 3. Relationship between important aspects of the Process of Management 5

Chapter II. A data system design on behalf of the operational management 8
§ 1. The teaching program 8
§ 2. The first stock-taking of Running-Research Projects 9
§ 3. Personnel 10
§ 4. The space available 10

Chapter III. Implementation of a data system on behalf of the operational management 11
§ 1. Relation between teaching program and personnel requirement 11
§ 2. The space requirements 15

Chapter IV. Design and information of a data system on behalf of the strategic management 17

Introduction/Summary

The University of Wageningen takes care of only one faculty with 80 departments and about 4000 students. The University has been, especially during the past years, growing very fast. The influx of first-year students is increasing by 25 percent a year.

Because of this growth but also because of various social developments a good data system is a requirement that the Board of the University can no longer do without. This data system is used to support and take part in the process of management, which means it has to correspond with the intrinsic characteristics of this process; therefore, in chapter I the process of management is described in brief.

From this appears that various aspects of the process of management (such as the teaching and research task, personnel etc.) are strongly related to each other, consequently one must know what these relationships are to the others. The end of chapter I gives a qualitative description of some of these relationships. From this short description of some properties of the process of management a first impression of a data system is derived, which is described in chapter II and IV. Chapter II gives the design of a data system on behalf of operational management while chapter IV handles strategic management.

The last part was up till now given less attention, therefore only a few pertinent thoughts and activities are described in chapter IV.

Chapter III gives the implementation of the data system on behalf of the operational management.

Chapter I. Some remarks about the Process of Management

§ 1. Aspects and phases of the Process of Management

The process of management of a university covers many different subjects (aspects). Most of the time these bear reference to task and resources. The task includes all the teaching and research activities; while personnel, space and equipment are the principal resources relating to these activities. In the cadre of the process of management each of the mentioned aspects can be split up into sub-aspects; table 1 gives a partial description.

Table 1. Main and sub-aspects referring to the process of managements of universities.

Aspect	Subaspect
Teaching	- Alteration of teaching task resulting from a change of departments (chair appointments)
	- Growth of the teaching task as a result of the increasing number of students
	- Academic level
	- Duration of courses - duration of studies
	- Composition of curriculum
	- Demand for teaching/graduates
Research	- Composition of the departments
	- Level
	- Ratio size teaching task/size research task
Personnel	- Quantitative composition
	- Level
	- Qualitative composition
	- Achievement/salary
Space	- Size and composition of the respective space-usage categories
Equipment	- Inventory
	- Composition
	- Administration

The process of management is related to all of these aspects and subaspects. Several have a strategic, others a more operational nature.

The process of managements itself has two important phases: presenting a policy and evaluating it against the actual situation. If there is a deviation between the actual situation and the policy, the consequences of this evaluation per aspect may mean that the policy of the aspect concerned,

has to be adjusted. Another possibility is to adjust the policy of other aspects so that the actual situation is better correlated to the policy concerned. If, for example, it turns out in practice that length of studies is much longer than expected (policy) this policy related to the length of studies can be adjusted. However, if the actual time of studies has to be shortened (in correspondence with the original policy) the policy related to the required level or related to the number of personnel or related to the composition of the curriculum has to be changed.

The advantage of this description of the process of management enables us to look at the subjects (aspects) of importance for a data system design, and also makes especially clear that a data system has to be designed which will enable the relations between the respective aspects to be analysed and interpreted.

§ 2. The data system: a support to the Process of Management

The process of management relies in such a high degree upon the information system that activities related to the information system have to be considered as a part of the process of management. The information system is based on a sequence of activities consisting of:

a. Gathering and filing data. This leads to the formation of the data system.
b. Analysing and interpreting data.

In figure 1 the data system is shown as a part of the process of management.

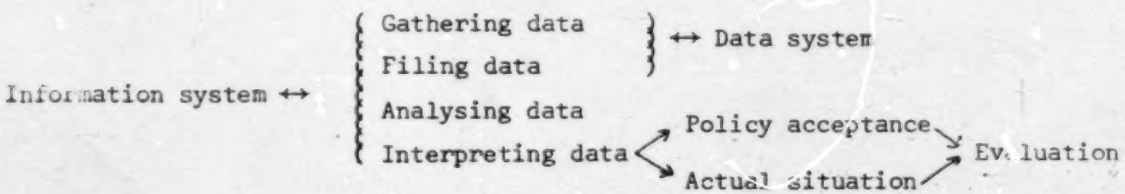

Figure 1. The process of management.

At the University of Wageningen the data of the respective aspects and subaspects are gathered and filed in a decentralised way. The administrative departments gather information on those subjects in which they are most involved. Thus, data about personnel are available wholly in the personnel department and partly also in the finance department (salary administration and personnel budgeting); building inventories are in the building department and the teaching programs are in the teaching administration departments; the duration of studies (student enrolment) is notated by the

department for student documentation and statistics, etc. This decentralised set-up of the data system is a historical outgrowth. The higher the demands on the governing body the greater the need for a clear insight into the consequences of their decisions in relation to all the aspects such as the teaching program, the use of resources and so forth. This means that one must ever more clearly perceive the often complicated relationships between the various aspects. To analyse and interpret these relationships one must pay even greater attention to the coordination between the various parts of the data system.

At the University of Wageningen there is set up a planning department to coordinate and extend the planning activities of the university. In close cooperation with the other administrative departments this planning department is trying to work on both the extension and coordination of the existing decentralised data system. The planning department tries by means of analysis and interpretation to clarify these relationships and thereby to support by their policy decisions the Governing body and the various administrative departments. The results of these analyses are also important for a correct evaluation of the actual situation. Table 2 shows the information system activities schematically.

Table 2. Information system activities

Aspect		Data system at:	
Teaching, Research	Task	- Teaching and Research administrative dep.	
Personnel		- Personnel dep. - Finance dep.	Planning department is involved in:
Buildings		- Building dep.	- extension data system
Equipment etc.		- Finance dep.	- coordination " "
Length of studies		- Student documentation and statistics dep.	- analyses and interpretations
Student enrolement		- Teaching and Research administrative dep.	

In the chapters II, III and IV set up and application of a part of this data system will be discussed. The next paragraph describes the relationship between the various aspects of the process of management.

§ 3. Relationship between important aspects of the Process of Management

As described repeatedly in preceding paragraphs the complexity of the process of management is directly related to the intricate relationship between the aspects of the process of management. Therefore the University of Wageningen has paid much attention to these relationships.
A relationscheme is drawn (see figure 2) and discussed in this paragraph in a qualitative way. The quantitative effects in so far as they are already known will be given in the following chapters.

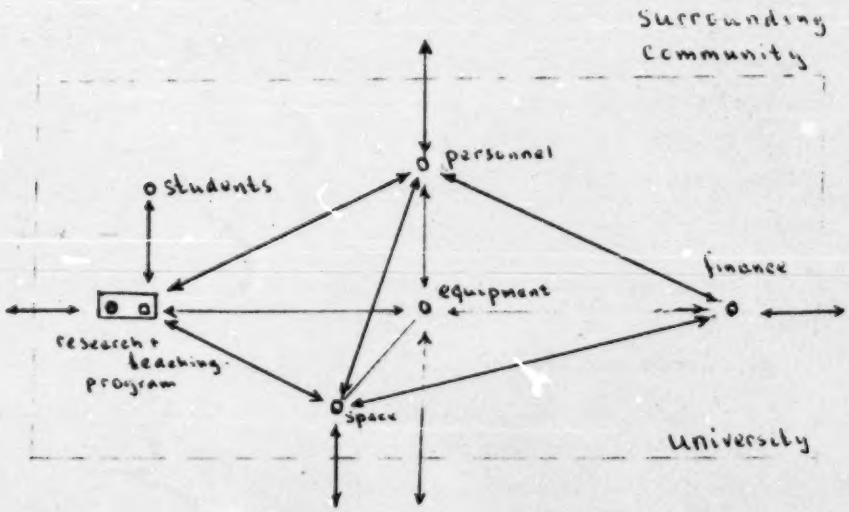

figure 2. Relationscheme.

Explanation figure 2.
a. Arrows I up to V represent the relationship between the University of Wageningen and its surrounding environment (outside community). Arrows 1 up to 10 represent the mutual relationships between these aspects.

b. The relationscheme is based on these main relationships:

task ↔ resources ↔ money

The size of the teaching task depends on the number of students. The quantitative influence on the teaching task is dependent on the teaching program, composition and the way of carrying out of the curriculum. Therefore it is most of the time incorrect when disposing of resources to consider the direct relationship between students and resources (student/staff ratio, m^2/student). These relations can only be used after analysing the teaching programs according to the type and composition of the curri-

culum and these relationships are verified per type of teaching activity of a given teaching program.
At the University of Wageningen the size of the teaching task is calculated by a mathematical formula. The number of students and the intrinsic characteristics of the program and curriculum occur as variables.

c. One of the most important ways to describe the size of the teaching task is to define the personnel requirement. In appendix A the formul[illegible] and the way they were calculated are given. These show the personnel requirement found from the number of students and the teaching program (relationship 1 and 2 from figure 2).

d. Personnel requirements influence in an important way space requirements: that is workrooms, laboratories, etc. (relationship 5, figure 2).
Space requirements can also be partly related to the teaching-program, that is, space needed for group activities such as lecture rooms and rooms for practical work (relationship 3, figure 2).
At the University of Wageningen the relations 3 and 5 from figure 2 have been investigated.

e. Towards relations 4, 6 and 7 of figure 2 not too much research attention has yet been given. The major part of the budget is absorbed by personnel and space requirements causing priority to be given to the estimations of these factors. However, it has to be said, that equipment requirements is an important factor, while equipment shortage may affect efficiency of the personnel on site in a serious way.
Relations concerned with equipment requirements are also important if technical or financial reasons give reason to consider the use of substitutes for the input of personnel, space or equipment.

f. Relations between means and money (relations 8, 9 and 10) are of course well known. These relations are drawn in this scheme to emphasize the main relationships: task ↔ resources ↔ money.

g. Relations 1 up to 10 are important for operational as well as for such strategic management.

h. Relations between the community and the University of Wageningen are shown in figure 2 by arrows I up to V.
Relation I concerns the reciprocal effect between teaching demand and graduates on one hand and the number of students the University of Wageningen can accept on the other.
Relation IV concerns the reciprocal effect between teaching and research programs in respect to the University's intentions and as the society it-

self (i.e. government, other universities, etc.) demand.
Relations II, III and V concern the reciprocal effect on the intentions of the University of Wageningen on one hand and the possibilities within the community with regard to resources (money) on the other.
Presence of the relations I to V expresses the importance of the knowledge of the production management as determined from the relations 1 to 10. Also these relations, especially I and IV, appeal to the University of Wageningen's own vision of its teaching task.

Chapter II. A data system design on behalf of the operational management

In this chapter further investigations are made in that part of the data system related to teaching program, research program, personnel and space available. For this purpose those parts of the data system used to analyse the relations between task and resources are discussed.

§ 1. The teaching program

The teaching program of each section is split up into teaching elements[1] (see table 3 as an example). From each teaching element is taken:

a. a short description and a sequence number per section
b. a code to classify the type of teaching element (lectures, practices, etc. see app. A)
c. The phase of the study in which the element is given
d. The number of students - N (classified per specialisation) to which education is given in a given year of studies
e. The length - L - of the educational activities, repetitions not included, expressed in contact hours (for group educational activities) or man hours per student (for the individual educational research tests)
f. The maximum number of students - M - able to follow the educational activity (maximum group size)
g. The number of times - H - a teaching activity is given in a year
h. The lecturer(s)
i. The room where the activity takes place (group activities).

From each teaching element the teaching load (= man hours given by the lecturing staff to teaching element) is calculated.
This is done by means of formulae, set up per code and phase of study (see app. A)[2] and the determined values of N, L, M and H.
Then from each teaching element the number of student equivalents is calculated. This is done by calculating the hours used by the students for the teaching elements. App. A[2] shows the simple relations used per type (code) of teaching element. The hours calculated in this way, divided by the annual task of a student gives the number of student equivalents. Finally one takes into consideration the contribution to the education per teaching element, given by non-academic staff of the department (= technical personnel, external lecturers, etc.). The contribution is evaluated as a percentage of the teaching load of the teaching element concerned.

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1) A teaching element is that teaching unit wherein a defined quantity of material is given in a homogeneous way (of teaching).

2) With regard to the implementation of the gathered data many formulae are drawn; but as examples, only some of the formulae are given here.

Vakgroep: WISKUNDE (064.0)

nr.	omschrijving	gids:
01.	differentiaal	210-01
02.	lineaire Algebra	210-02
03.	prop. wiskunde practicum	210-03
04.	elementaire statistiek	210-04
05.	pract.elementaire statistiek	210-05
06.	wiskundige statistiek	210-06
07.	practicum wiskunde statistiek	210-07
08.	toegepaste statistiek TS-o	210-08
09.	pract.toegepaste statistiek TS-o	210-09
10.	toegepaste statistiek TS-1a	210-10
11.	pract.toegepaste stat. TS-1a	210-11
12.	toegepaste statistiek TS-1b	210-12
13.	pract.toegepaste stat. TS-1b	210-13
14.	toegepaste statistiek TS-2	210-14
15.	pract. toegep. stat. TS-2	210-15
16.	toegepaste stat. TS-3	210-16
17.	pract. toegep. stat. TS-3	210-17
18.	toegep. stat. TS-4	210-18
19.	pract. toegep. stat. TS-4	210-19
20.	toegep. stat. TS-5	210-20
21.	pract. toegep. stat. TS-5	210-21
22.	toegep. stat. TS-6	210-22
23.	pract. toegep. stat. TS-6	210-23
24.	toegep. stat. TS-7	210-24
25.	pract. toegep. stat. TS-7	210-25
26.	toegep. stat. TS-8	210-26
27.	pract. toegep. stat. TS-8	210-27
28.	toegep. stat. TS-9	210-28
29.	pract. toegep. stat. TS-9	210-29
88.	correctie huiswerk toeg. stat.	-
89.	correctie huiswerk elem. stat.	-

68 TABEL 3. ONDERWIJSINVENTARISATIE 72-73

NR	KODE	N	L	M	H	D	OB	SE	73-74 N	L	M	H	OB	SE
1	PR 11	940	52	550	2	0	364	101.8	ONGEWIJZIGD				364	101.8
2	PR 11	940	26	550	2	0	182	50.9	ONGEWIJZIGD				182	50.9
3	PR 40	980	52	35	28	0	3666	35.4	ONGEWIJZIGD				3666	35.4
4	PR 11	250	26	550	1	0	156	13.5	ONGEWIJZIGD				156	13.5
5	PR 40	230	26	90	3	20	403	4.2	ONGEWIJZIGD				403	4.2
6	KA 11	520	39	300	2	0	273	38.0	ONGEWIJZIGD				273	38.0
7	KA 40	520	26	60	9	20	860	8.4	ONGEWIJZIGD				860	8.4
8	KA 11	300	2	300	2	0	14	1.1	ONGEWIJZIGD				14	1.1
9	KA 40	450	2	150	3	20	48	.6	ONGEWIJZIGD				48	.6
10	KA 11	200	10	300	1	0	60	3.8	ONGEWIJZIGD				60	3.8
11	KA 40	200	10	80	3	20	143	1.3	ONGEWIJZIGD				143	1.3
12	KA 11	80	10	300	1	0	60	1.5	ONGEWIJZIGD				60	1.5
13	KA 40	80	10	50	2	20	85	.5	ONGEWIJZIGD				85	.5
14	KA 11	50	6	300	1	0	36	.6	ONGEWIJZIGD				36	.6
15	KA 40	50	6	50	1	20	37	.2	ONGEWIJZIGD				37	.2
16	KA 11	90	10	300	1	0	60	1.7	ONGEWIJZIGD				60	1.7
17	KA 40	90	10	90	1	20	79	.6	ONGEWIJZIGD				79	.6
18	KA 11	40	4	300	1	0	24	.3	ONGEWIJZIGD				24	.3
19	KA 40	40	4	50	1	20	23	.1	ONGEWIJZIGD				23	.1
20	KA 11	90	10	300	1	0	60	1.7	ONGEWIJZIGD				60	1.7
21	KA 40	90	10	90	1	20	79	.6	ONGEWIJZIGD				79	.6
22	KA 11	130	10	300	1	0	60	2.4	ONGEWIJZIGD				60	2.4
23	KA 40	130	10	80	2	20	105	.8	ONGEWIJZIGD				105	.8
24	KA 11	250	8	300	1	0	48	3.8	ONGEWIJZIGD				48	3.8
25	KA 40	250	8	80	3	20	130	1.3	ONGEWIJZIGD				130	1.3
26	KA 11	50	6	300	1	0	36	.6	ONGEWIJZIGD				36	.6
27	KA 40	50	6	80	1	20	37	.2	ONGEWIJZIGD				37	.2
28	KA 11	70	6	300	1	0	36	.8	ONGEWIJZIGD				36	.8
29	KA 40	70	6	80	1	20	42	.3	ONGEWIJZIGD				42	.3
88	KA 175	0	0	0	0	80	1575	0	ONGEWIJZIGD				1575	0
89	PR 175	0	0	0	0	80	690	0	ONGEWIJZIGD				690	0
				TOTAAL		19	25710	328.5					26401	328.5

§ 2. The first stock-taking of Running Research Projects

Two reasons made this inventory necessary:

a. To provide management, committees and departments with suitable material leading towards a vision of the present research situation from which one can begin to form a vision of a future research program.

b. To analyse the relations between research task and the resources needed for it.

These considerations lead up to the principal questions of the enquiry-sheet (see app. B) which asks for a short description of the research project and the resources needed for it (for the time being only questions about personnel resources).

For those also trying to take an inventory of the running research projects for the first time, here some remarks.

1. At the University of Wageningen such an inventory was not taken before last year. Many research workers have maintained in the past that such a stock-taking as part of planning procedure clashed with their freedom to work in a creative way.
2. Many research workers have found it difficult to furnish the data asked for because on one hand it is hard to estimate the future development of a running research project, while, often, on the other hand, no adequate administration has been maintained of resources used.
3. The problems handled under 1 and 2 (to which still various smaller problems can be added) necessitated a very careful carrying-out of the enquete. Therefore the presentation of the enquete to each department was accompanied by a discussion of it personelly with them in order to overcome any initial resistance to it.
4. Some technical problems concerned the division between the time used for teaching and the time used for research as well as over the research unit. Because of its evaluation possibilities, for the time being the research unit is described as the work done for one publication.
5. The enquete revealed that the almost 500 research workers of the University of Wageningen described together on about 1200 research units. The enquiry must be repeated several times and improved before an operational management (a.o. allocation of resources) can be based upon it. The first results however offer the possibility of beginning a more strategic management concerning the main development lines of the research programs (see chapter IV).

§ 3. Personnel

At the personnel department a vast data system of the entire personnel is present.
Deductions from relations between task and personnel requirements and also from relations between personnel and space requirements lead to the partial use of the given personnel data system; that is, the number and composition of the available and occupied personnel places in the university as a whole and per department.
Concerning the composition, three main categories can be separated:
a. the academic staff
b. the technical staff
c. the administration staff

§ 4. The space available

At the building department plans of all buildings are present (scale 1:200).
The rooms inventory in the buildings is up till now restricted to:
the floor surface, in m^2 per room,
a description of the use of each room; on this basis each room is classified in a space usage category.
The various space usage categories are mentioned in table 4.
For the University as a whole, as well as for each department, the area inventory in m^2 per space usage category is taken.

Table 4. Various space usage categories at the University of Wageningen[1].

Lecture rooms	Students' studies
Practice rooms	Workshops and warehouses
Work-rooms	Libraries
Laboratories	Canteen and meeting spaces
"Conditioned" rooms (rooms furnished with control over temperature, light, ventilation, humidity, etc.)	Storage
	Green houses
	Small animal housing
Special equipment rooms	"Work Space" (garages, stables etc.)
Rough-work laboratories	
Fotography and drawing rooms	

1) Space usage categories mentioned in table 4 refer to the Functional Net Area (F.N.) of the departments.
Therefore, halls, staircases, sanitary rooms, etc. are not included in table no. 4.

Chapter III. Implementation of the data system on behalf of the operational management

The implementation, here discussed, is restricted to an qualitative description of the analyses of the relation between task (teaching task) and resources (personnel and space).
A description of the results gives an impression the support they offer to operational management.

§ 1. Relation between teaching program and personnel requirements

A. In the first place personnel requirements per department are calculated for the presents situation, that is, starting with personnel, the teaching program and the curriculum composition of the moment.
The personnel requirement is given according to the average personnel resources available at the University of Wageningen.
Tables 3, 5 up to 10 give an estimate of the personnel requirement needed by one single department.
Discussion of these tables follows below:
Table 3 shows the teaching elements and number of student equivalents. A description of this table 3 is given in chapter II.1.
Table 5 shows a classification of the teaching load according to the teaching code (or group of codes) per phase of study (the various phases of study are: propaedeutic (PR), undergraduation A (KA). undergraduation B (KB), graduation (IR) and post-graduate (DR).
Table 6 is equal to the set-up of table 5, here student equivalents are classified per phase of study.
Table 7 shows per teaching code per phase of study the academic staff requirement. This need is calculated by dividing the theaching load by the average teaching load (= total calculated teaching load of the University of Wageningen divided by the total number of academic staff places).
The total academic staff requirement is calculated for the various phases of study and teaching code (or group of codes); the total academic staff requirement is given in table 7 on the right hand, below.
Further, a correction of this calculated number of academic staff places is made in two ways: Firstly, by bringing into account the way in which a department takes care of its teaching elements. This correction is calculated by comparing the student/academic staff ~~per~~ ratio per teaching element with the average student/academic staff ratio for the comparable type of teaching elements and phases of study. The result of this comparison is a teaching intensity.

TABEL 5 OVERZICHT ONDERWIJSBELASTING IN 72-73.

KODE	11-20	30	40	50-67	90	101-102	121-122	131-132	141-142	175	180	REST	TOTAAL	PERC
PR	702	0	4069	0	0	3007	0	0	0	690	0	0	8468	33
KA	1001	0	1933	156	0	1160	0	0	0	3135	0	0	7385	29
KB	1040	0	766	161	0	613	0	0	0	4000	0	0	6580	26
IR	1248	320	132	341	0	496	150	0	0	0	0	0	2687	10
DR	0	0	0	0	0	0	0	140	0	0	0	0	140	1
--	0	0	0	0	0	0	0	0	0	0	450	0	450	2
TOTAAL	3991	320	6900	658	0	5276	150	140	0	7825	450	0	25710	
PERC	16	1	27	3	0	21	1	1	0	30	2	0	100	

TABEL 6 OVERZICHT STUDENTAEQUIVALENTEN IN 72-73.

KODE	11-20	30	40	50-67	90	101-102	121-122	131-132	141-142	175	180	REST	TOTAAL	PERC
PR	166.29	0	39.54	0	0	6.61	0	0	0	0	0	0	212.45	65
KA	58.00	0	15.34	.51	0	1.67	0	0	0	0	0	0	75.52	23
KB	27.04	0	5.08	.81	0	.75	0	0	0	0	0	0	33.67	10
IR	4.48	.38	.32	.76	0	.17	.72	0	0	0	0	0	6.84	2
TOTAAL	255.82	.38	60.28	2.08	0	9.20	.72	0	0	0	0	0	328.48	
PERC	78	0	18	1	0	3	0	0	0	0	0	0	100	

TABEL 7 AANTALLEN WP. BEREKEND UIT ONDERWIJSBELASTING.

KODE	11-20	30	40	50-67	90	101-102	121-122	131-132	141-142	175	180	REST	TOTAAL
PR	.67	0	3.89	0	0	2.87	0	0	0	.66	0	0	8.09
KA	.96	0	1.85	.15	0	1.11	0	0	0	2.99	0	0	7.06
KB	.99	0	.73	.15	0	.59	0	0	0	3.88	0	0	6.29
IR	1.19	.31	.13	.33	0	.47	.14	0	0	0	0	0	2.57
DR	0	0	0	0	0	0	0	.13	0	0	0	0	.13
--	0	0	0	0	0	0	0	0	0	0	.43	0	.43
TOTAAL	3.81	.31	4.59	.63	0	5.04	.14	.13	0	7.48	.43	0	24.56

TABEL 8 ONDERWIJSINTENSITEIT. BEREKEND UIT TABELLEN 2 MET 3.

KODE	11-20	30	40	50-67	90	101-102	121-122	131-132	141-142	175	180	REST	TOTAAL
PR	.73	1.00	.97	1.00	1.00	.97	1.00	1.00	1.00	1.00	1.00	1.00	.81
KA	.40	1.00	.94	.99	1.00	.93	1.00	1.00	1.00	1.00	1.00	1.00	.68
KB	.33	1.00	.92	.50	1.00	.61	1.00	1.00	1.00	1.00	1.00	1.00	.65
IR	1.10	1.47	1.01	1.05	1.00	1.06	1.05	1.00	1.00	1.00	1.00	1.00	1.57
TOTAAL	.27	1.19	.92	.90	1.00	.72	1.06	1.00	1.00	1.00	1.00	1.00	.42

TABEL 9 CORRECTIE OP TABEL 4 DOOR MIDDEL VAN TABEL 5.

KODE	11-20	30	40	50-67	90	101-102	121-122	131-132	141-142	175	180	REST	TOTAAL
PR	-0.25	0	-0.10	0	0	-0.08	0	0	0	0	0	0	-1.94
KA	-1.46	0	-0.11	-0.00	0	-0.08	0	0	0	0	0	0	-3.32
KB	-2.02	0	-0.07	-0.15	0	-0.37	0	0	0	0	0	0	-3.33
IR	.11	.10	.00	.02	0	.03	.01	0	0	0	0	0	.93
TOTAAL	-10.50	.05	-0.54	-0.07	0	-1.93	.01	0	0	0	0	0	3.58

TABEL 10 PERSONELE MIDDELEN IN 72-73.

CATEGORIE	FORMATIE		BEHOEFTE	
WETENSCHAPPELIJK PERSONEEL	15.0	9.56	9.72	5.98 + 8.04
TECHNISCH PERSONEEL	1.0	1.48	3.06	
ADMINISTRATIEF PERSONEEL	2.0	1.40	3.31	
		Δp1	Δp2	ΔWp3

Table 8 shows the calculated teaching intensity per teaching code per phase of study. At the same time teaching intensity is shown per study-phase (right hand vertical column); this teching intensity is calculated by comparing the student/academic staff ratio per study-phase with the average student/academic staff ratio's of the comparable phases of study at the University of Wageningen. The horizontal column below shows in the same way the teaching intensity per department per type of teaching element. Finally on the right hand below the overall teaching intensity is shown per department compared with the average value at the University.

Table 9 shows the effect of the correction of teaching intensity upon the personnel need. The need[1] for academic personnel corrected in this way is Δ wp (3).

The second way to correct the academic personnel requirements found in table 7 is achieved by deducting that part of the task due to external lectures, technical personnel, etc. from the task of the academic staff teaching load.

The academic staff need estimated in this way is Δ wp (2).

Table 10 shows a survey of the present personnel places per category (academic staff) (wp), technical personnel (tp) and administrative personnel (ap), and also the calculated difference between Need and Availability: Δ wp1, Δ wp2, Δ wp3, Δ tp and Δ ap.

Both of the last figures are derived from the average situation at the University calculated from the number of academic staff places per department.

Results found in this way per department are compared: as examples figure 3 gives the mean teaching load per science staff member per department, and figure 4 the values of Δ wp1 per department.

The actual meaning of the value Δ wp, Δ tp and Δ ap depends on the quantity of the number of personnel places per dept.

Therefore, priorities are set on a base of the relative shortage or surplus as given by the ratio: Δ wp/wp; Δ ap/wp; Δ tp/wp.

Figure 5 shows the shortage priorties.

The calculations made in this way function as a support for management in allocating personnel from the point of view of the existing teaching program and present curriculum composition.

B. Regarding management support for teaching and personnel the implementation has been extended much further.

Thus, the effect of the composition of the teaching curriculum, the length

1) The figures of tables 3, 5 up till 10 are only given as an example, they don't necessarily describe the actual situation.

of the teaching matter, the number of students, etc. on the personnel requirements is researched.
Also the maximum student influx capacity can be calculated by an assumed personnel-composition, teaching program and curriculum composition.
As an example the effect of changes in number of students on the teaching load (= personnel requirement) is worked out in the following text.

This effect can be given for the University of Wageningen as a whole, as well as for the separate departments. Calculations are restricted to the University as a whole.
The starting point in every case was the present student number and teaching program. This teaching program can be subdivided in a number of teaching elements, indicated by the way in which the matter is handled (lectures, practices, teaching research projects, etc.).
Dependent upon the number of students and dependent upon the way the present teaching program is changing due to the changes in the number of students, the teaching load per teaching element can be calculated as the teaching load expressed in the man hours of the academic staff personnel.
Calculations are made to determine three different possible changes in the teaching program concerned.

Alternative 1. In increasing the number of students, the size of the groups to be tought will increase, the length of the teaching elements and the number of repetitions do not change.

Alternative 2. In increasing the number of students the number of repetitions per type of teaching element will increase. The size of the groups and the length of the teaching elements will not change.

Alternative 3. In increasing the number of students the total length and also the number of repetitions of the respective teaching elements will increase. The groupsize will not change.

All these calculations started from one common point, namely the mutual relation between the various types of teaching elements (the curriculum composition) which does not change.
In the case of equal changes of the number of students alternative 1 gives the smallest change in the teaching load and alternative 3 the largest.
In the tables below for the three alternatives the calculated teaching load (expressed in man hours academic staff personnel) is given for a number of types of teaching elements in relation to the number of students.

Table 1. Value of teaching load (in man hours academic staff personnel) for some teaching elements, in the case of an increased number of students, assuming only the size of the groups to be taught will increase, while the length of the teaching elements and number of repetitions do not change.

	number of students				
	3280	4920	6560	8200	9840
teaching load lectures	90.170	90.170	90.170	90.170	90.170
" " practices	143.440	169.259	195.078	220.897	246.716
" " teaching research projects (exp.)	91.260	136.890	182.520	228.150	273.780
teaching load teaching research projects (litt.)	9.612	14.418	19.224	24.030	28.836
total	334.482	410.737	486.992	563.247	639.503

See also graph 6.

Table 2. Value of teaching load (in man hours academic staff personnel) for some teaching elements in the case of an increased number of students, assuming the number of repetitions per type of teaching element will increase while the size of the groups and the length of the teaching elements do not change.

	number of students				
	3280	4920	6560	8200	9840
teaching load lectures	90.170	97.158	104.146	111.134	118.122
" " practices	143.440	198.664	253.888	309.112	364.337
" " teaching research projects (exp.)	91.260	136.890	182.520	228.150	273.780
teaching load teaching research projects (litt.)	9.612	14.418	19.224	24.030	28.836
total	334.482	447.130	559.778	672.426	785.075

See also graph 7.

Table 3. Value of teaching load (in man hours academic staff personnel) in the case of an increased number of students, assuming the group size does not change, but the total length and also the number of repetitions of the respective teaching elements do increase.

	number of students				
	3280	4920	6560	8200	9840
teaching load lectures	90.170	106.851	123.532	140.213	156.894
" " practices	143.440	202.968	262.496	322.024	381.552
" " teaching research projects (exp.)	91.260	136.890	182.520	228.150	273.780
teaching load teaching research projects (litt.)	9.612	14.418	19.224	24.033	28.836
total	334.482	461.127	587.772	714.417	841.062

See also graph 8.

In graph 9 the teaching load for the three alternatives is shown. Also drawn in this figure is the extent to which the teaching load changes if the length of the total teaching program changes proportional to the increase of the number of students.

§ 2. The space requirements

In the analyses done up till now the space requirements are related only to teaching program and to personnel.

A. The direct relationship between the teaching program and the space requirements

This relationship analysed for those teaching elements which are followed by groups of students all at the same time (lectures, practices, etc.; these take up 72% of the teaching curriculum from the student point of view) and the rooms needed for this. These rooms occupy for the moment 12% of the Functional Net Area. This relation is analysed as follows:

1. Data gathered while taking inventory of teaching elements gives the possibility of calculating the accurate number of hours that lecture and practice rooms were occupied during the past year (hours occupied = BT) and the proportion to which every room was filled with students (average extent of place-filling = GVG). Results are shown by graphs 10 and 11.

2. From every group of rooms also the average time of occupation (GBT) and average extent of place-filling (GVG) can be calculated. For results see graph 12. This graph show a survey of the intensity of the occupation of the rooms and a first impression which room type is most in demand.
3. The need of room space depends on the number of students, the composition of the teaching curriculum and the maximum values that can be kept for the average time of occupation (GBT) and average extent of place filling (GVG).

Relations between GVG, GBT, number of students (following a certain curriculum) and the need for a room are determined[1]. With the help of these relations at a given maximum value for GBT and GVG and a given room inventory, the maximum student influx capacity can be calculated as well as the needed roomarea for a given number of students. In this way the relations between the teaching task and the roomarea needed is estimated in an implicit way, while the effect of the number of students is connected to the teaching program and the composition of the curriculum. In these relations are also handled the kind of program to be given and the composition of the curriculum. Some results are illustrated in a graphical way. Graph 13 shows the relation between the number of students, GBT and GVG at the present room capacity and teaching curriculum. Graph 14 shows the room area as a function of GBT and GVG and the number of students at the present teaching curriculum being constant. Graph 15 shows the maximum student influx capacity as a function of the GBT and the percentage space-demanding practices at training for the actual curriculum at a GVG of 75% and for the actual total space resources.

B. The relations between personnel and space requirements

As far as possible for the University of Wageningen relations have been determined between personnel and available space.
This was done by calculating the relations per department between personnel and certain space usage categories and as far as this was reasonable to take the average throughout the university. In this way a series of relations is found which describes the use of the average space categories situation at the university. About 40% of the available space could be related to the personnel in this manner.
By using these relations (as standards for the time being) the shortage or surplus of space per department can be established per space category concerned. Also the future space requirement can be established dependent on the expected change in the number of personnel.
The result of applying the provisional standards on the separate departments are given in graph 16.

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1) As noted before most of the formulae and the way they were determined are not shown.

Chapter IV. Design and implementation of a data system on behalf of the strategic management.

In the cadre of strategic management one of the most important aspects of the management procedure is the nature and size of the future teaching and research task. Related subaspects are the development of the demand for education and for post-graduates, the future duration of courses, the ratio between the load of the teaching- and research task, the kind of research program, etc.

Development of many of these aspects is closely correlated to the resources available. Therefore it is important to have as claer as possible vision of the desired development of the task in order to set priorities as early as possible.

To determine the strategic management needed for the future type and size of the teaching and research task it is necessary to design a suitable data system. Such a data system can promote strategic management by better influencing developments and leaving less to change. In The Netherlands, where in the cadre of the improved planning procedure the division of tasks between the universities becomes central, such a data system must surely be developed for each university. The design of a suitable data system begun at the University of Wageningen is described in the next paragraph.

Appendix A.

I Summary of the quantitative relationship and the way these are estimated at the University of Wageningen between the number of students and the teaching program on one hand and the personnel requirement on the other. An enquete is held to find out these relationships in which cadre following activities are carried out:

1. The teaching program is split up in teaching elements of different characteristical types (see table A of this Appendix A). From each teaching element following data are taken: N (number of students), L (hours of contact length of eductional matter), M (maximum group size), H (number of times the activity is given a year) and the study - phase.
2. From each department the teaching activities were tabulated and each cooperator mentioned individually the hours spend to each of the various teaching elements in the year involved.
   Hours per teaching element were broken down in:
   fraction A: hours spent during program contact times as giving lectures, practical leadership, etc.
   fraction B: hours spent during preparation for the first time, as writing syllaby, etc.
   fraction C: hours spent during routine preparation and finishing the job as preparation of the speech for a lecture and inspection of the material for practices etc.
   fraction D: hours spent on every individual student : as correctionwork on practice reports or written examinations, etc.
   fraction BG: average hours spent for preparation for once. This number of hours was not only restricted to the year of the enquete.

   At the same time these detailed data were taken from the teaching program also the number of hours spent on other activities as research, management, services, etc. were taken.
3. From each teaching element the measured time fraction , dependent from the type of teaching element is related to one or more of the variables N, L, M and H.
   The following relationship between the teaching load T and the variables N, L, M and H were found and shown in table A of this Appendix.
4. The relationship of table A, is investigated for all types of teaching elements and study phases. The quantitative result is given in table B of this Appendix.

II Table C gives the relationship between the task (S) per student and the length (L) of the teaching elements.

Table A (Appendix A) : The relationship between teaching load, T, and variables N, L, M and H for the various types of teaching elements.

a. All types of lectures and colloquia:

$$T = \left(\frac{(\Sigma A + \Sigma BG + \Sigma C)}{\Sigma L} \right) \times L_t^{1)} + \left(\frac{\Sigma D}{\Sigma (L \times N)} \right) \times L_t^{1)} \times N_t^{1)}$$

B. All types of practices

$$T = \left(\frac{\frac{1}{2}(\Sigma A + \Sigma C) + \Sigma D}{\Sigma (L \times N)} \right) \times L_t \times N_t + \left(\frac{\frac{1}{2}(\Sigma A + \Sigma C)}{\Sigma (L \times H)} \right) \times L_t \times H_t +$$

$$+ \left(\frac{\Sigma BG}{\Sigma L} \right) \times L_t$$

c. Excursions

$$T = \left(\frac{(\Sigma A + \Sigma BG + \Sigma C + \Sigma D)}{\Sigma (L \times H)} \right) \times L_t \times H_t$$

1) L_t, N_t, M_t, and H_t are the variables L, N, M, and H in a given year t.

d. Oral examinations

$$T = \left(\frac{(\Sigma A + \Sigma BG + \Sigma C + \Sigma D)}{\Sigma (L \times N)} \right) \times L_t \times N_t$$

e. Written examination

$$T = \left(\frac{(\Sigma A + \Sigma D)}{\Sigma (L \times N)} \right) \times L_t \times N_t + \left(\frac{\Sigma C}{\Sigma (L \times N)} \right) \times L_t \times H_t$$

f. Teaching Research projects

$$T = \left(\frac{(\Sigma A + \Sigma BG + \Sigma C + \Sigma D)}{\Sigma (L \times N)} \right) \times L_t \times N_t$$

g. Ph.D. Thesis and practical times

$$T = \left(\frac{(\Sigma A + \Sigma BG + \Sigma C + \Sigma D)}{\Sigma N} \right) \times N_t$$

Appendix A 4

Table B (Appendix A) : The quantitative relationships between teaching load, T, and variables N, L, M and H for the various types of teaching elements.

a Various types of lectures

type 1 : $T = 6 \times L_t$
type 2 : $T = 9 \times L_t$
type 3 : $T = 7 \times L_t$
type 4 : $T = 8 \times L_t$

b Various types of practices

type 1 : $T = 3{,}3 \times L_t + 0{,}04 \times L_t \times N_t + 1{,}0 \times H_t \times L_t$
type 2 : $T = 2 \times L_t + 0{,}08 \times L_t \times N_t + 2 \times H_t \times L_t$
type 3 : $T = 2 \times L_t + 0{,}15 \times L_t \times N_t + 2{,}3 \times H_t \times L_t$
type 4 : $T = 1{,}5 \times L_t + 0{,}10 \times L_t \times N_t + 1{,}0 \times H_t \times L_t$
type 5 : $T = 1{,}5 \times L_t + 0{,}15 \times L_t \times N_t + 1{,}5 \times H_t \times L_t$

c Excursions

$$T = 4{,}0 \times L_t \times H_t$$

d Oral examinations

$$T = 1{,}8 \times L_t \times N_t$$

e Written examinations

$$T = 0{,}3 \times L_t N_t + 5{,}0 H_t L_t$$

f Various types of teaching research projects

type 1 : $T = 0{,}06 \times L_t \times N_t$
type 2 : $T = 0{,}13 \times L_t \times N_t$

Appendix A 5

g Various types of practical time

type 1 : $T = 5,5 \times N_t$
type 2 : $T = 15,5 \times N_t$

h Ph. D. Thesis

$$T = 35,0 \times N_t$$

Table C (Appendix A) : The quantitatieve relationships between the task(s) per student and the length of the teaching elements (L).

a All types of lectures

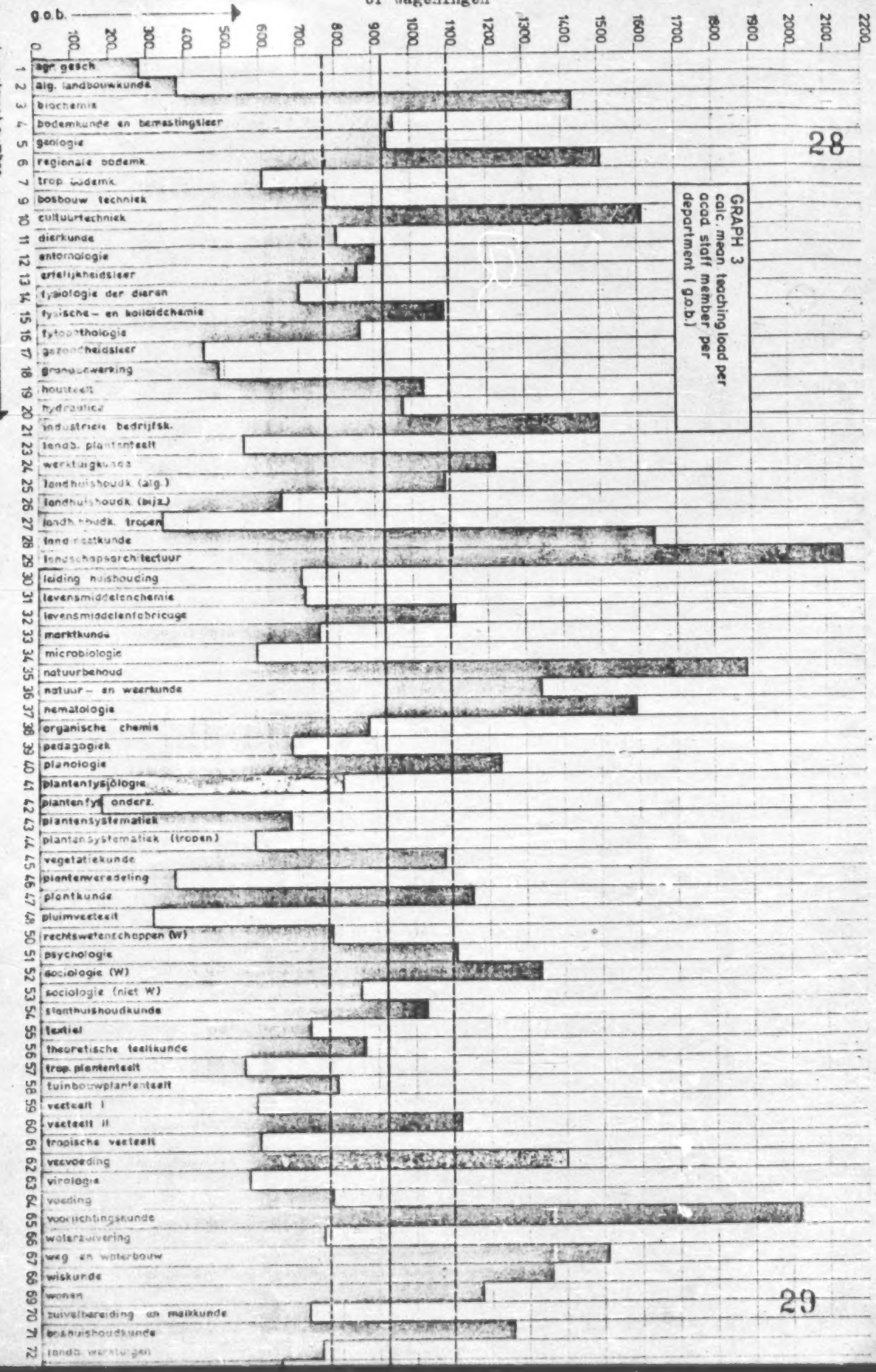
$$S = 3 \times L_t$$

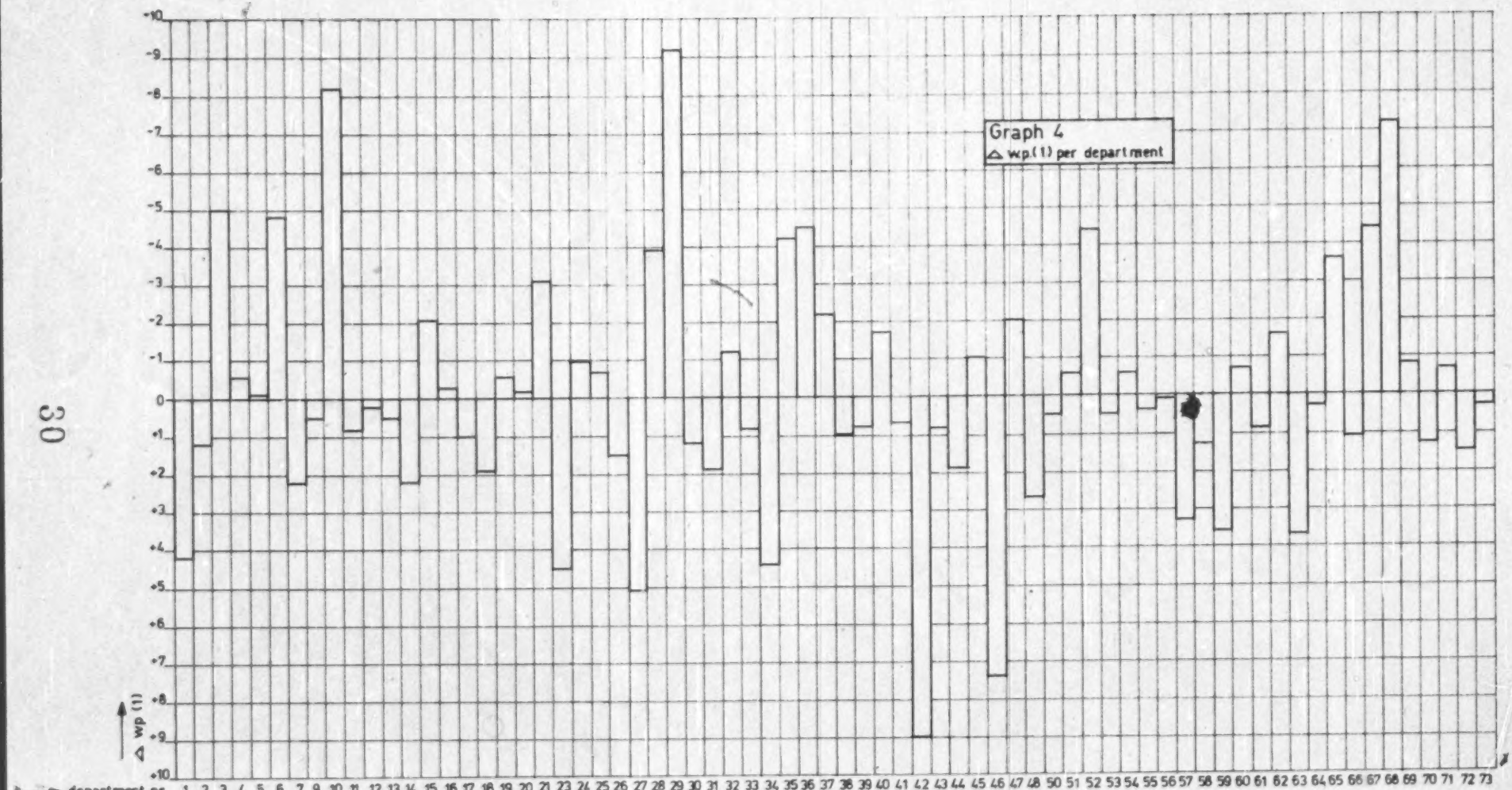
b All types of practices

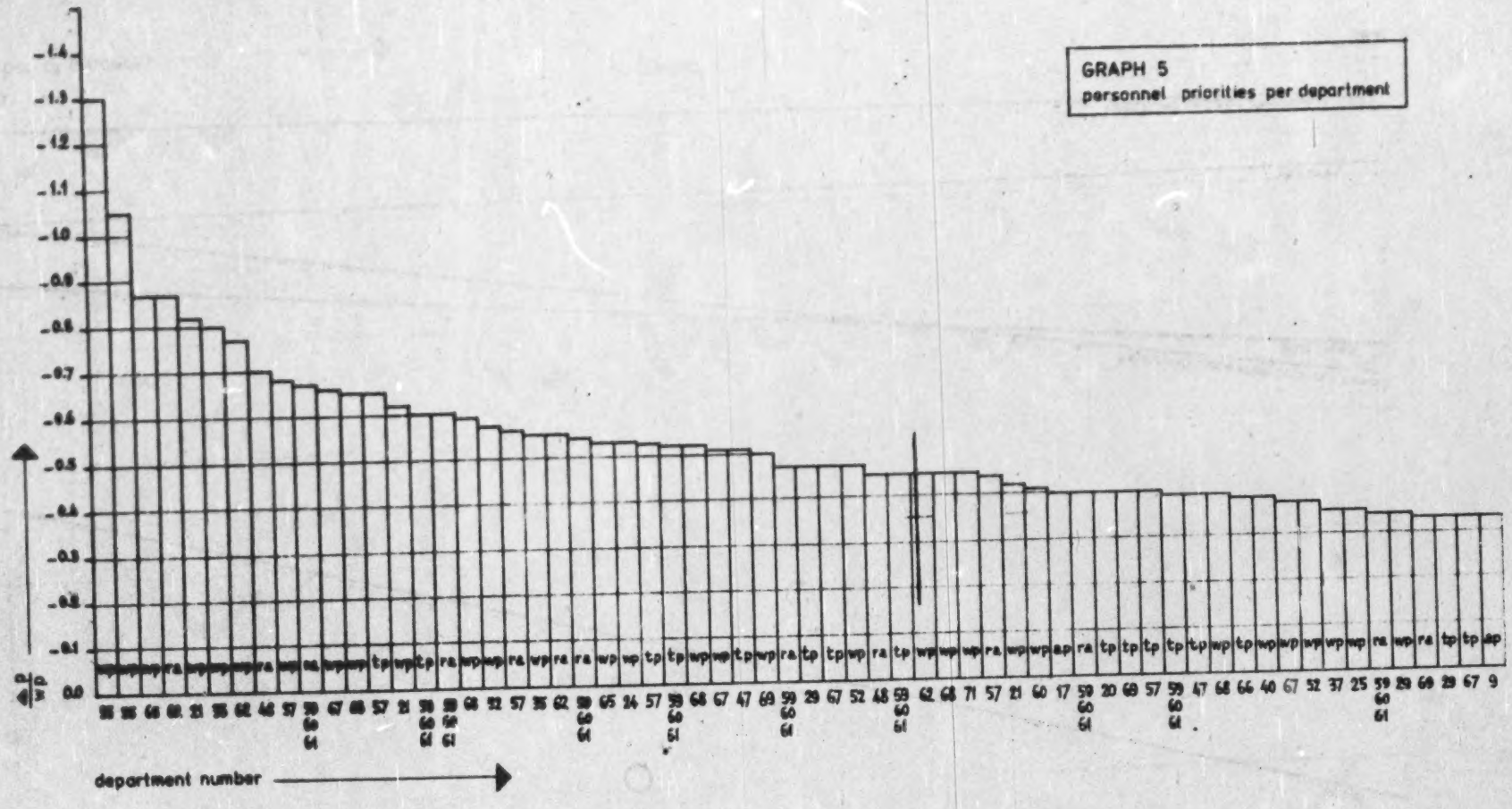
$$S = 1,25 \times L_t$$

c All other teaching elements

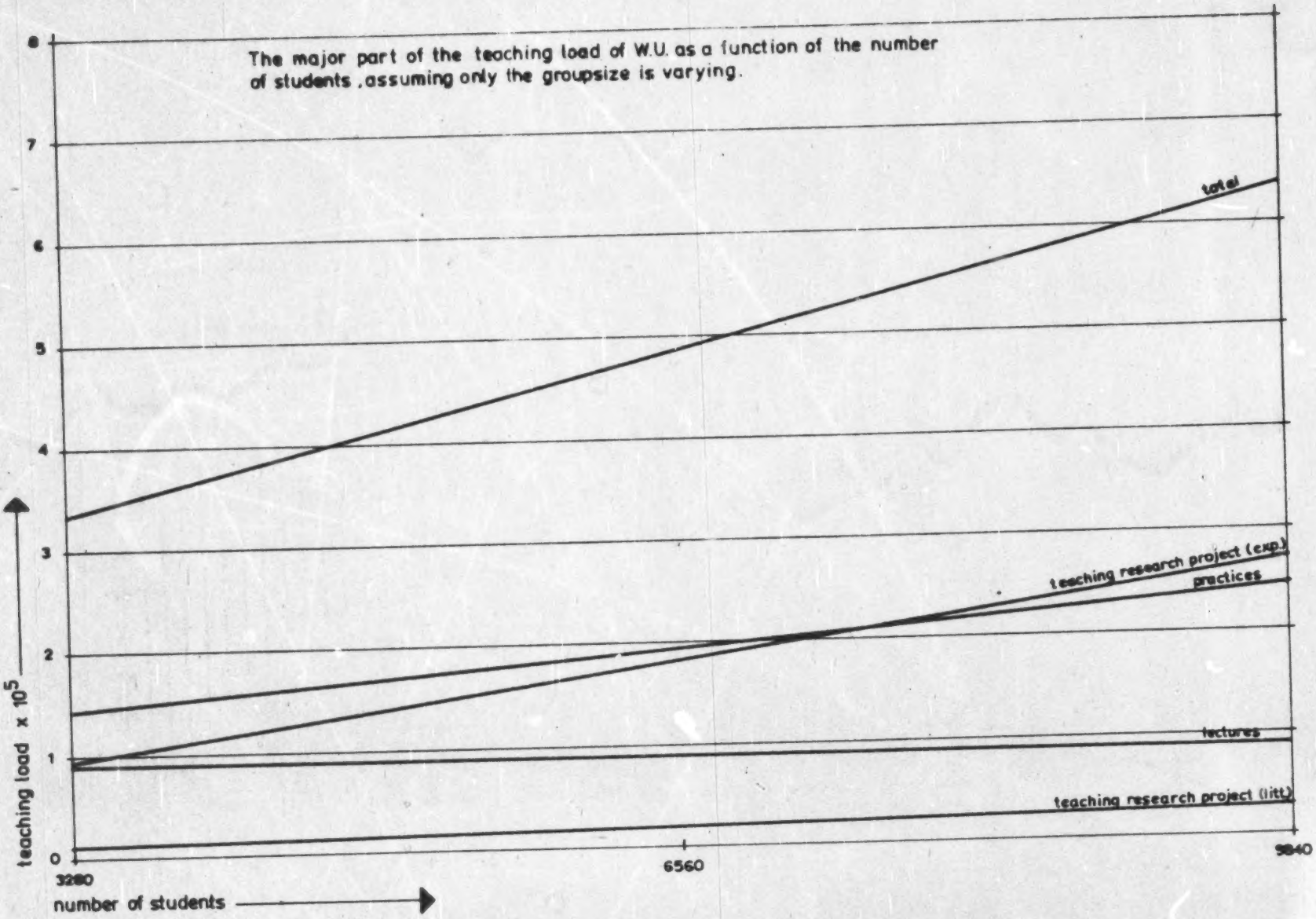
$$S = 1,0 \times L_t$$


g.o.b.
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100
2200
department number
1 agr. gesch
2 alg. landbouwkunde
3 biochemie
4 bodemkunde en bemestingsleer
5 geologie
6 regionale bodemk.
7 trop. bodemk.
9 bosbouw techniek
10 cultuurtechniek
11 dierkunde
12 entomologie
13 erfelijkheidsleer
14 fytologie der dieren
15 fysische- en kolloidchemie
16 fytopathologie
17 gezondheidsleer
18 graanbewerking
19 houtteelt
20 hydraulica
21 industrieel bedrijfsk.
23 landb. plantenteelt
24 werktuigkunde
25 landhuishoudk. (alg.)
26 landhuishoudk. (bijz.)
27 landb. houdk. tropen
28 landmeetkunde
29 landschapsarchitectuur
30 leiding huishouding
31 levensmiddelenchemie
32 levensmiddelenfabricage
33 marktkunde
34 microbiologie
35 natuurbehoud
36 natuur- en weerkunde
37 nematologie
38 organische chemie
39 pedagogiek
40 planologie
41 plantenfysiologie
42 plantenfys. onderz.
43 plantensystematiek
44 plantensystematiek (tropen)
45 vegetatiekunde
46 plantenveredeling
47 plantkunde
48 pluimveeteelt
50 rechtswetenschappen (W)
51 psychologie
52 sociologie (W)
53 sociologie (niet W)
54 stadhuishoudkunde
55 textiel
56 theoretische teeltkunde
57 trop. plantenteelt
58 tuinbouwplantenteelt
59 veeteelt I
60 veeteelt II
61 tropische veeteelt
62 veevoeding
63 virologie
64 voeding
65 voorlichtingskunde
66 waterzuivering
67 weg en waterbouw
68 wiskunde
69 wonen
70 zuivelbereiding en melkkunde
71 bedrijfshuishoudkunde
72 landb. werktuigen
GRAPH 3
calc. mean teaching load per acad. staff member per department (g.o.b.)

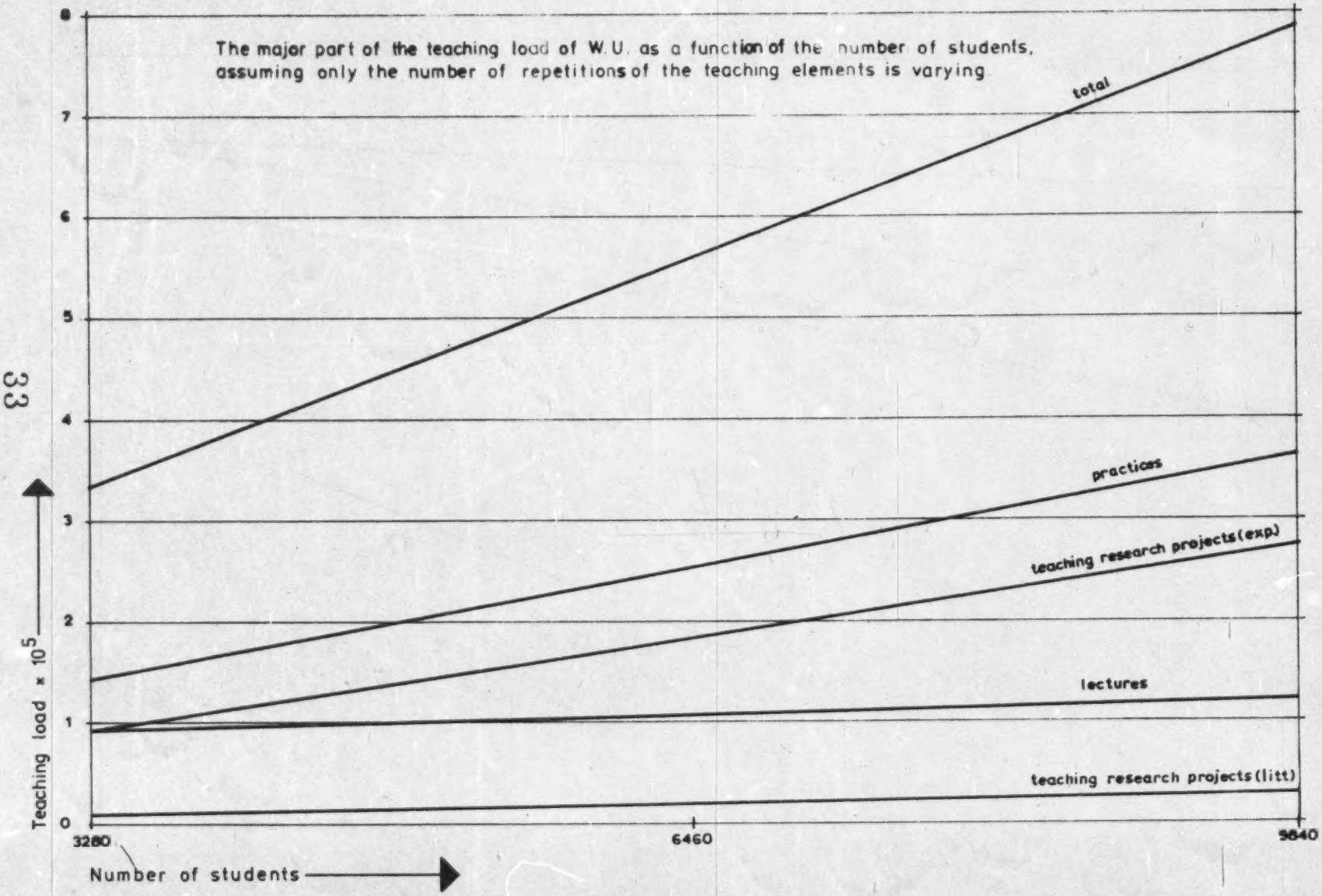

Graph 4
△ w.p.(1) per department
-10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5 +6 +7 +8 +9 +10
△ wp (1)
department nr 1 2 3 4 5 6 7 9 10 11 12 13 14 15 16 17 18 19 20 21 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73


GRAPH 5
personnel priorities per department
department number

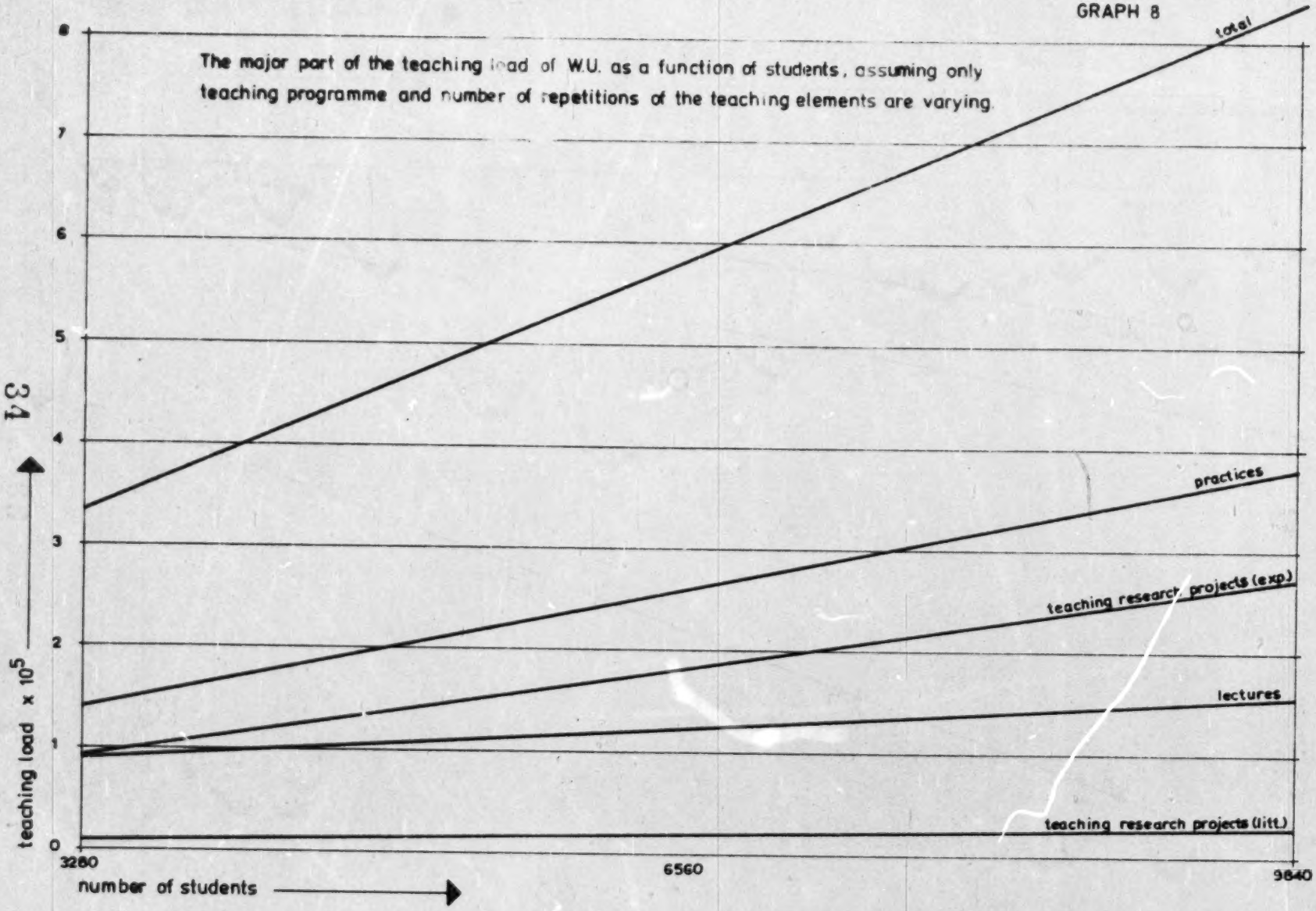
GRAPH 6


The major part of the teaching load of W.U. as a function of the number of students, assuming only the groupsize is varying.
total
teaching research project (exp.)
practices
lectures
teaching research project (litt.)
teaching load x 10^5
0
1
2
3
4
5
6
7
8
3280
6560
9840
number of students

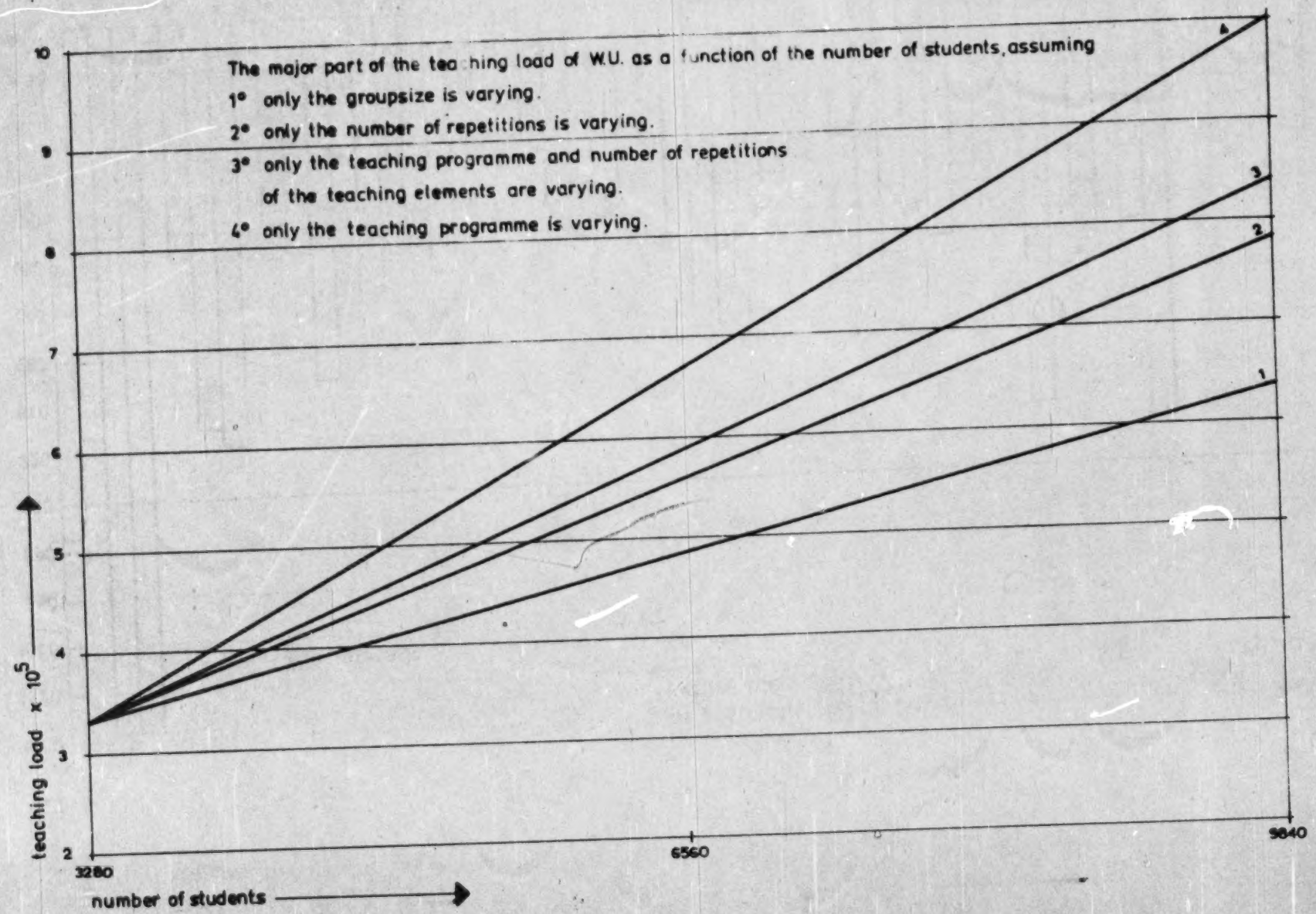
GRAPH 7


The major part of the teaching load of W.U. as a function of the number of students, assuming only the number of repetitions of the teaching elements is varying
total
practicas
teaching research projects (exp.)
lectures
teaching research projects (litt.)
Teaching load × 10^5
0
1
2
3
4
5
6
7
8
3280
6460
5840
Number of students

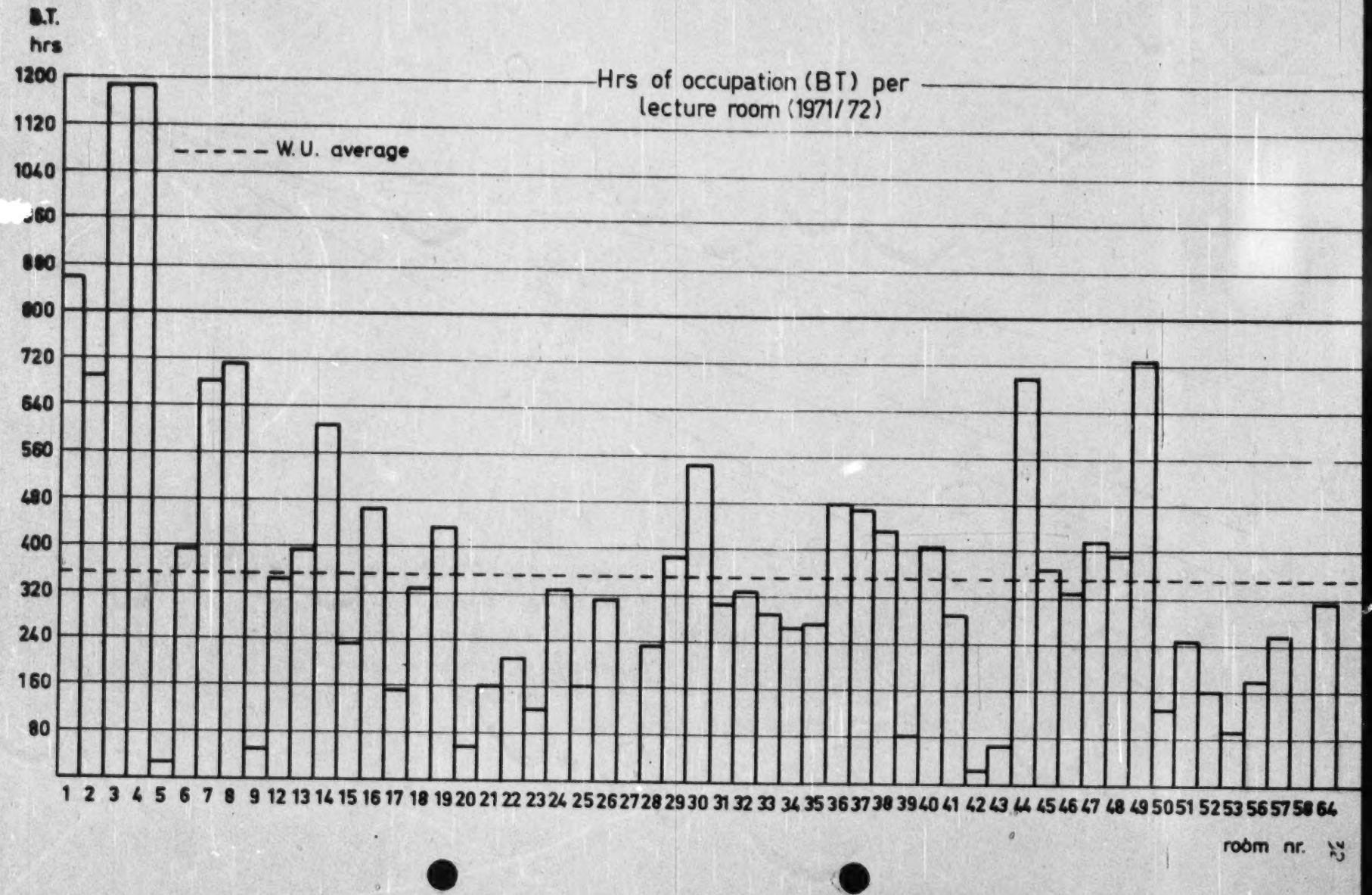
GRAPH 8


The major part of the teaching load of W.U. as a function of students, assuming only teaching programme and number of repetitions of the teaching elements are varying.
total
practices
teaching research projects (exp.)
lectures
teaching research projects (litt.)
teaching load x 10^5
0
1
2
3
4
5
6
7
8
3280
6560
9840
number of students

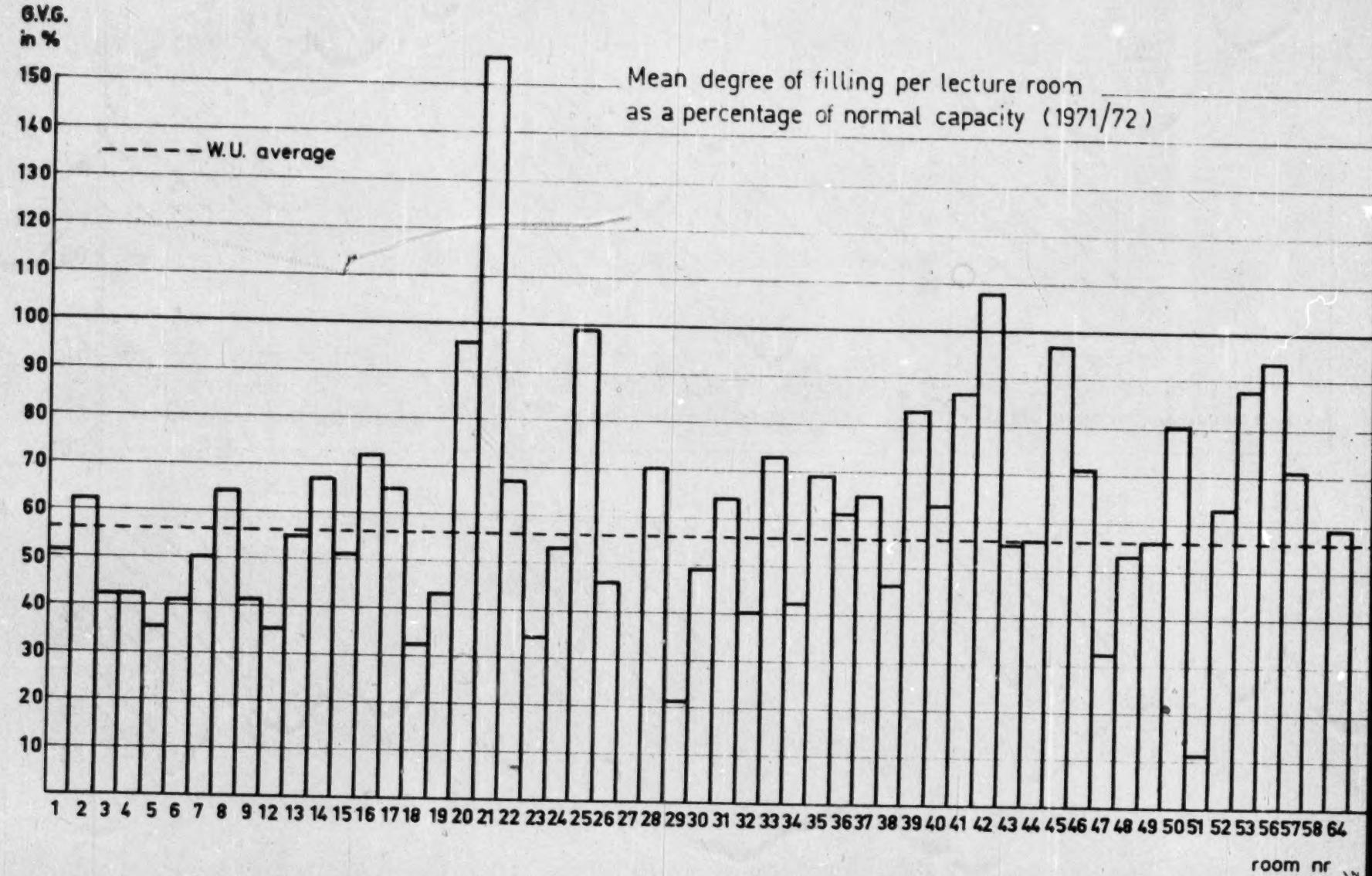
GRAPH 9


The major part of the teaching load of W.U. as a function of the number of students, assuming
1° only the groupsize is varying.
2° only the number of repetitions is varying.
3° only the teaching programme and number of repetitions of the teaching elements are varying.
4° only the teaching programme is varying.
4
3
2
1
10
9
8
7
6
5
4
3
2
teaching load x 10^5
3280
6560
9840
number of students

GRAPH 10

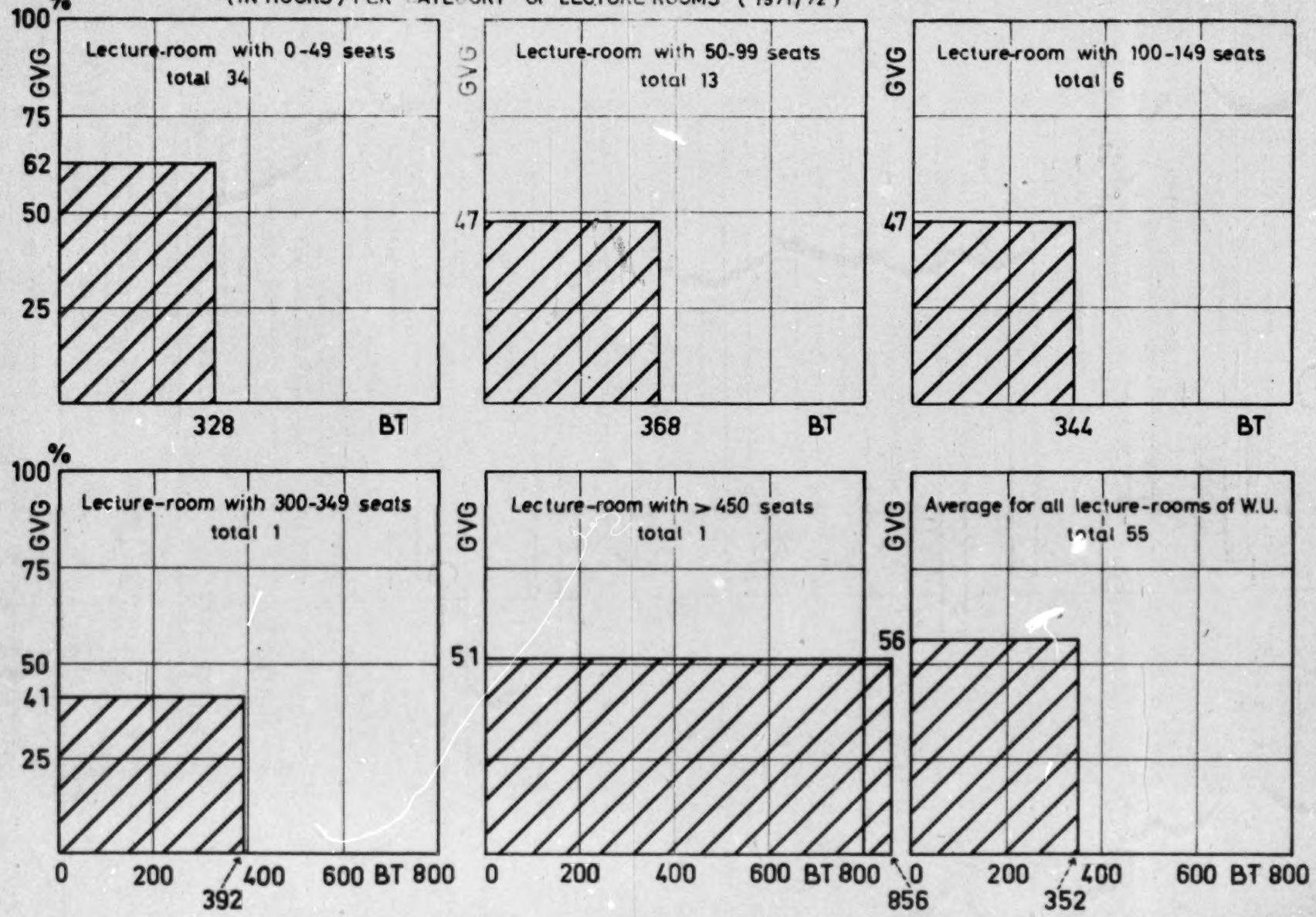

B.T.
hrs
1200
1120
1040
960
880
800
720
640
560
480
400
320
240
160
80
Hrs of occupation (BT) per lecture room (1971/72)
W.U. average
1 2 3 4 5 6 7 8 9 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 56 57 58 64
room nr.

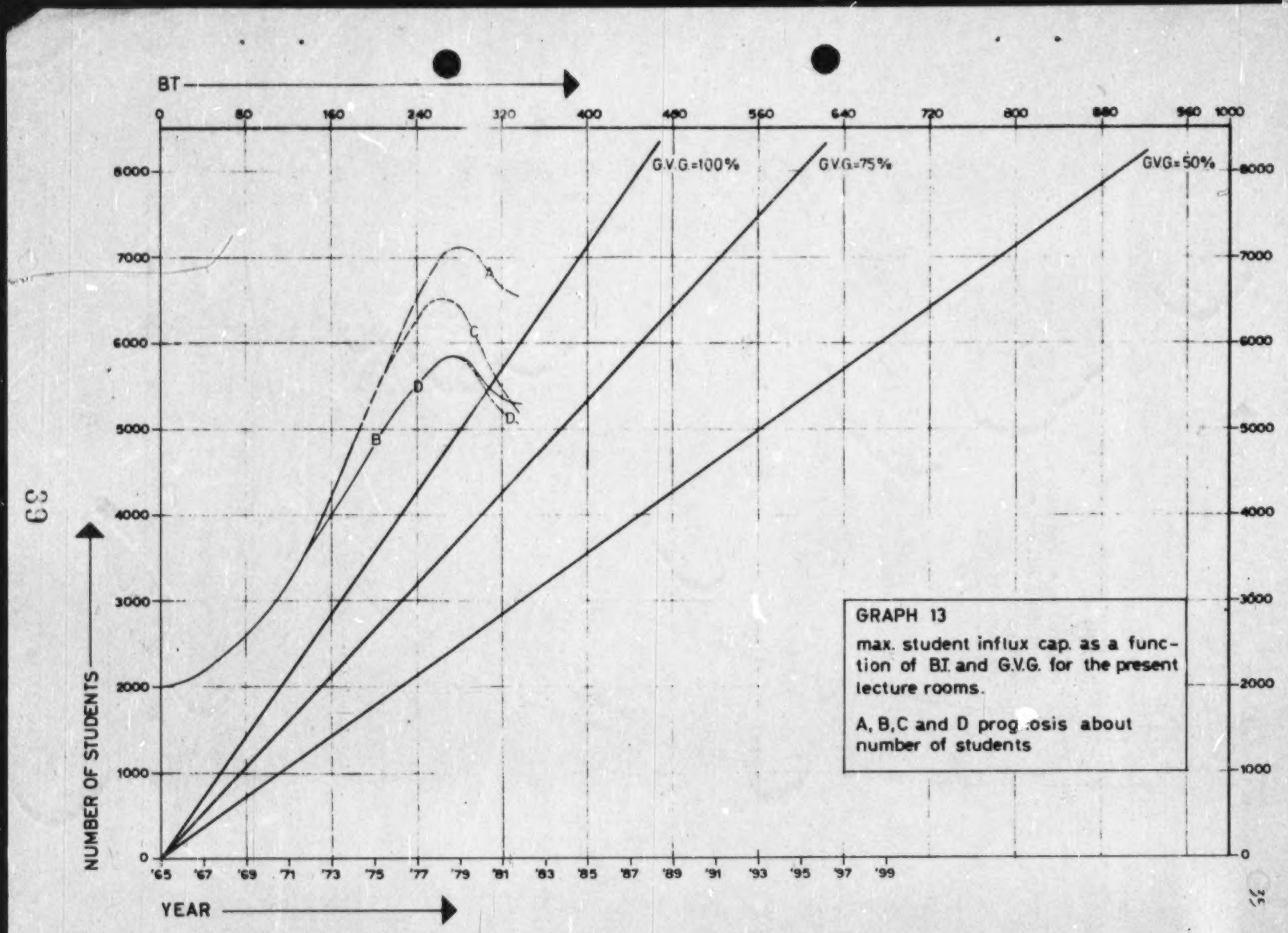
GRAPH 11

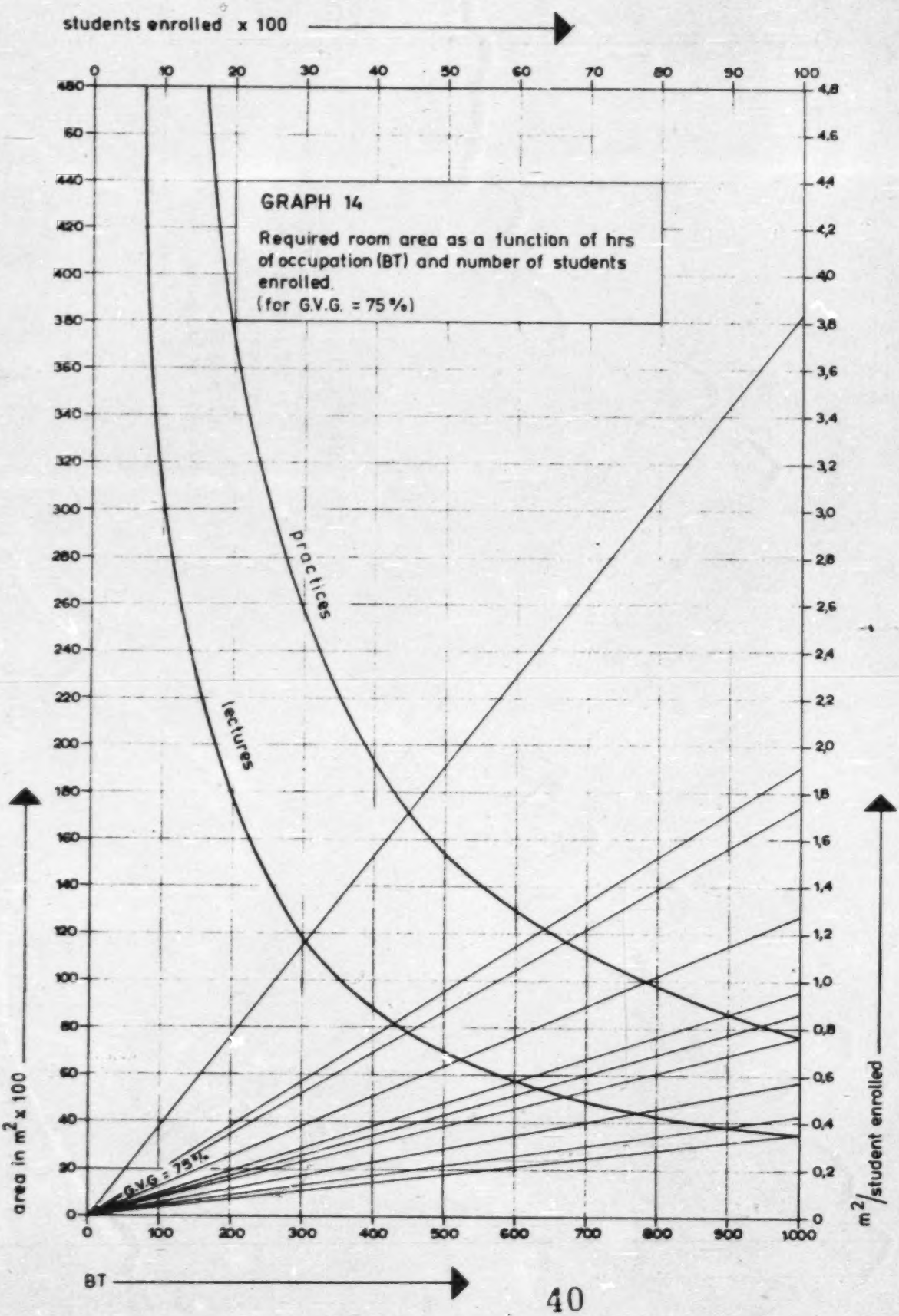

G.V.G. in %
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
W.U. average
Mean degree of filling per lecture room as a percentage of normal capacity (1971/72)
1 2 3 4 5 6 7 8 9 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 56 57 58 64
room nr

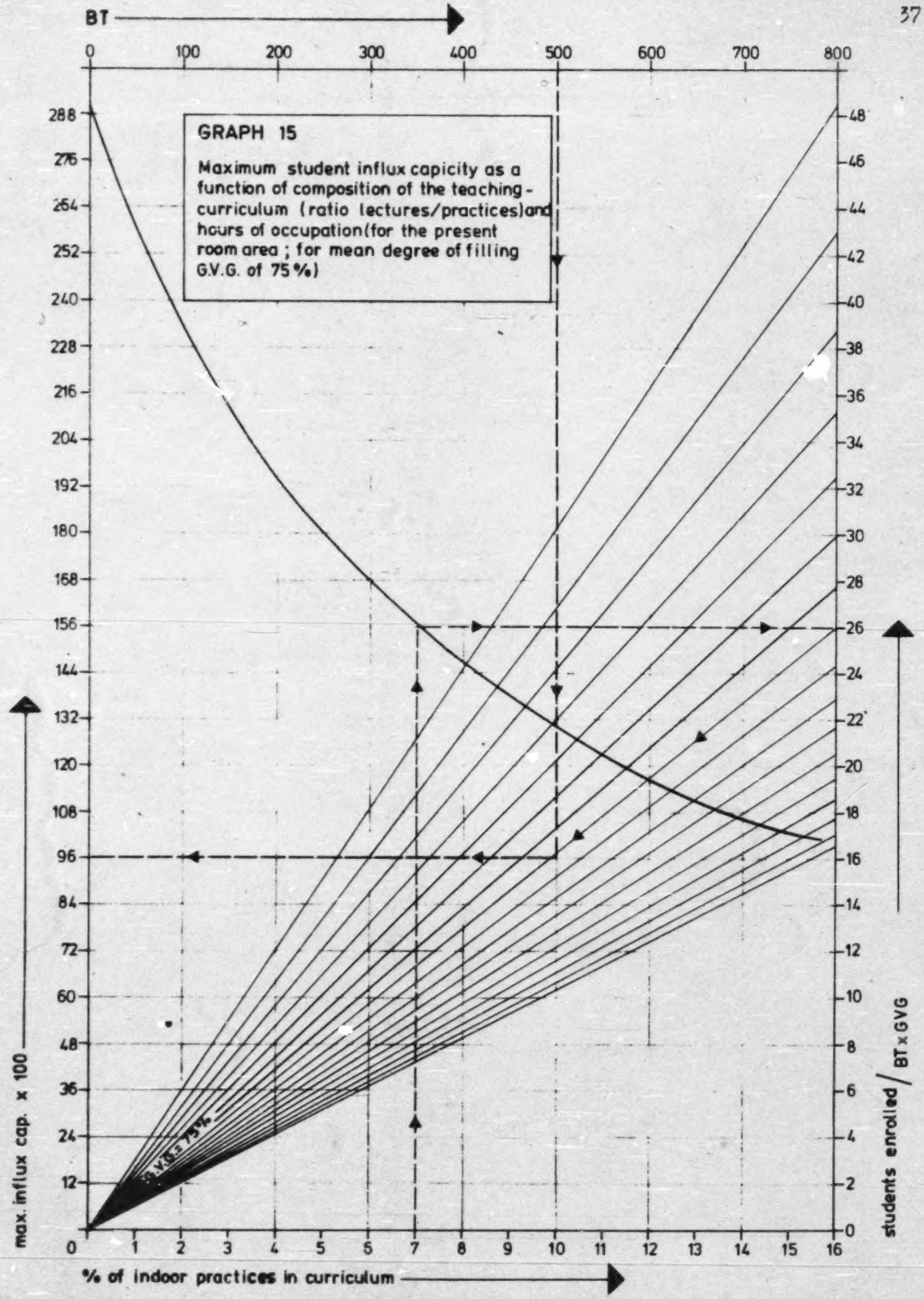
GRAPH 12

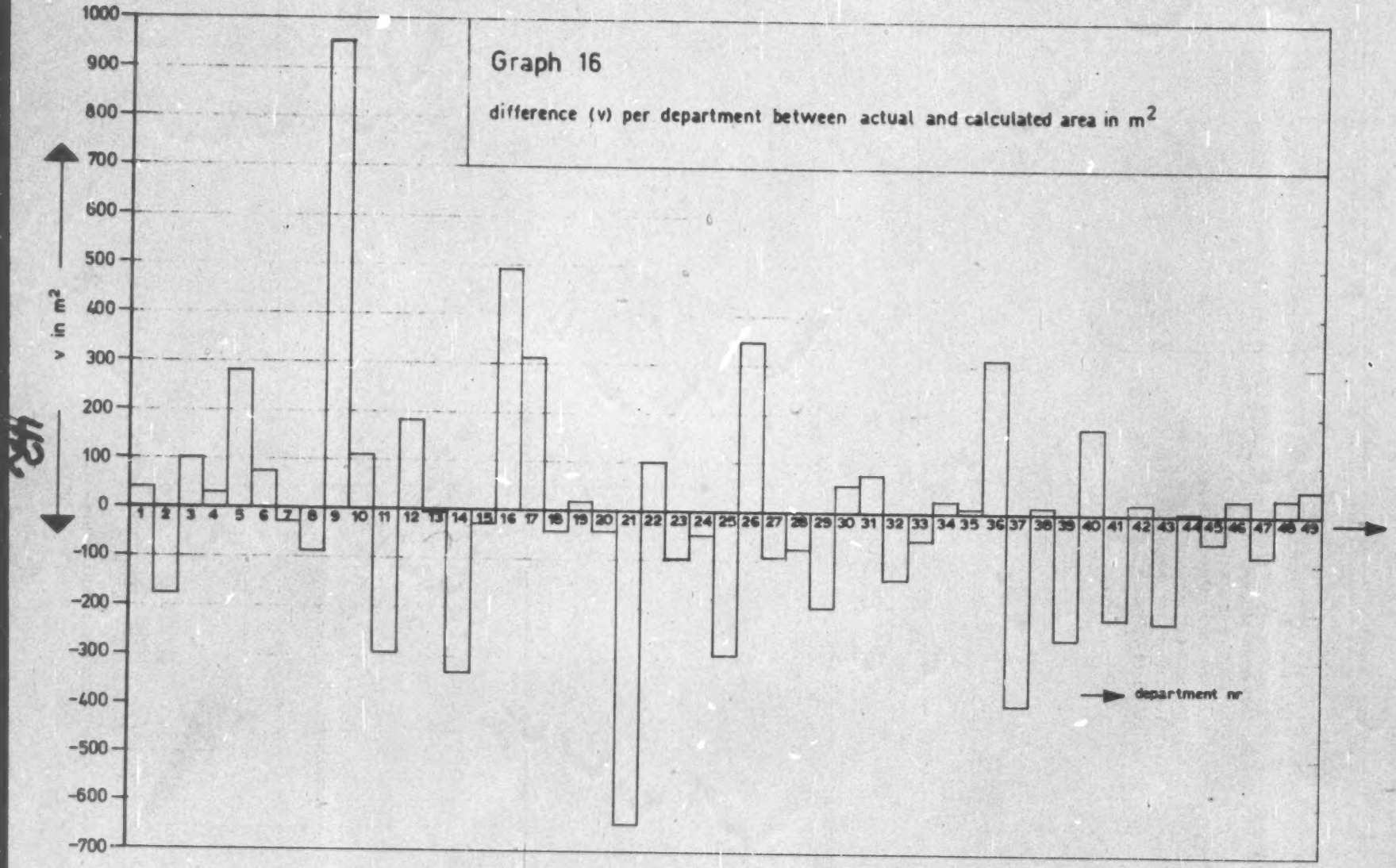
MEAN DEGREE OF FILLING (IN % OF NORMAL CAPACITY) AND DEGREE OF OCCUPATION (IN HOURS) PER CATEGORY OF LECTURE ROOMS (1971/72)




BT
0
80
160
240
320
400
480
560
640
720
800
880
960
1000
G.V.G.=100%
G.V.G.=75%
G.V.G.=50%
A
B
C
D
D
8000
7000
6000
5000
4000
3000
2000
1000
0
NUMBER OF STUDENTS
'65
'67
'69
'71
'73
'75
'77
'79
'81
'83
'85
'87
'89
'91
'93
'95
'97
'99
YEAR
GRAPH 13
max. student influx cap. as a function of BT and G.V.G. for the present lecture rooms.
A, B, C and D prognosis about number of students


students enrolled x 100
0 10 20 30 40 50 60 70 80 90 100
480 460 440 420 400 380 360 340 320 300 280 260 240 220 200 180 160 140 120 100 80 60 40 20 0
4,8 4,6 4,4 4,2 4,0 3,8 3,6 3,4 3,2 3,0 2,8 2,6 2,4 2,2 2,0 1,8 1,6 1,4 1,2 1,0 0,8 0,6 0,4 0,2 0
GRAPH 14
Required room area as a function of hrs of occupation (BT) and number of students enrolled.
(for G.V.G. = 75 %)
practices
lectures
G.V.G. = 75%
area in m² x 100
m²/student enrolled
0 100 200 300 400 500 600 700 800 900 1000
BT


BT
0
100
200
300
400
500
600
700
800
GRAPH 15
Maximum student influx capicity as a function of composition of the teaching - curriculum (ratio lectures/practices) and hours of occupation (for the present room area ; for mean degree of filling G.V.G. of 75 %)
288
276
264
252
240
228
216
204
192
180
168
156
144
132
120
108
96
84
72
60
48
36
24
12
0
max. influx cap. x 100
G.V.G. = 75%
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
% of indoor practices in curriculum
48
46
44
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
students enrolled / BT x GVG


Graph 16
difference (v) per department between actual and calculated area in m2
v in m2
1000
900
800
700
600
500
400
300
200
100
0
-100
-200
-300
-400
-500
-600
-700
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49
department nr